Introduction to SMR: Overview of NE Efforts

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### SMR: Definition and Target Applications

Advanced Reactors that produce electric power up to 300 MW, built in factories and transported as modules to utilities and sites for installation as demand arises.

A nuclear option to meet the need for **flexible** power generation for wider range of users and applications

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<th>Description</th>
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<td>Replacement of aging fossil-fired units</td>
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<td>Cogeneration needs in remote and off-grid areas</td>
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<td>Potential for enhanced safety margin through inherent and/or passive safety features</td>
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<td>Economic consideration – better affordability</td>
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<td>Potential for innovative energy systems:</td>
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<tr>
<td>• Cogeneration &amp; non-electric applications</td>
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<td>• Hybrid energy systems of nuclear with renewables</td>
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SMRs for Near, Medium and Long-term Deployment

Samples for land-based SMRs

Water cooled SMRs
- CAREM
- SMART
- ACP100
- NuScale

Gas cooled SMRs
- HTR-PM
- GTHTR300
- HTMR100
- X-Energy

Liquid metal cooled SMRs
- PFBR
- PRISM
- SVBR
- 4S
International Technical Working Group on SMR

- To advice and support IAEA programmatic planning and implementation in areas related to technology development, design, deployment and economics of SMRs
- 14 Member States and two International Organizations: European Commission and OECD-NEA as invited observers:

- More countries potentially to join: Canada, Japan, Saudi Arabia, South Africa, Tunisia and Ukraine

- Three technical subgroups established:
  - **SG-1**: Development of Generic Users Requirements and Criteria (GURC)
  - **SG-2**: Research, Technology Development and Innovation; Codes and Standards
  - **SG-3**: Industrialization, design engineering, testing, manufacturing, supply chain, and construction technology
- TWG will also address specifically SMR for Non-Electric Applications and coupling with renewables
Coordinated Research Projects

- **CRP on Design and Performance Assessment of Passive Engineered Safety Features in Small Modular Reactors** – focusing on integral PWR type SMRs (2017 – 2019) 11 MSs
  - Verification & Validation of methods for SMR’s engineered safety features performance assessment

- **CRP on Modular High Temperature Gas-cooled Reactor Safety Design** (2014 – 2018) 10 MSs
  - Propose safety design criteria from designers perspective based on the unique safety features of HTGRs (based on IAEA SSR-2/1 Safety of Nuclear Power Plants: Design)

- **CRP on Development of Approaches, Methods and Criteria for Determining Technical Basis for EPZ for SMR Deployment** (2018 – 2020) – 15 MSs
  - address aspects of emergency preparedness & response (EPR) specific for SMR deployment, particularly the size of EPZ;
  - A joint CRP between Department of Nuclear Energy and Department of Nuclear Safety & Security
Recent Publications and Forthcoming Ones

- **NES Technology Roadmap** for Small Modular Reactor Deployment
- **TECDOC**: Status of Approaches for Environmental Impact Assessment for SMR Deployment
- **TECDOC**: Options to Enhance Energy Supply Security using **Hybrid** Energy Systems
## Ongoing Support to Embarking Countries

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<th>Countries</th>
<th>Recent Milestone</th>
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• K.A.CARE performs a PPE with KAERI to prepare a construction of 2 units of SMART  
• An MOU between K.A.CARE and CNNC on HTGR development/deployment in KSA  
• TC project (2018- ) on SMRs and HTGRs |
| **Indonesia** | • Experimental 10 MW(th) HTR-type SMR was selected in March 2015 for a basic design work aiming for a deployment in mid 2020s  
• Site: R&D Complex in Serpong where a 30 MW(th) research reactor in operation  
• BAPETEN, the regulatory body has issued a site license  
• TC projects INS2016 / INS9026 support the owner / regulator (till August 2018)  
• BATAN initiated detailed design work / value engineering |
| **Jordan** | • Jordan, Saudi Arabia and Republic of Korea is to conduct a feasibility study for a deployment of SMART in Jordan  
• MOU signed with X-Energy (USA) on HTR technology  
• Technology assessment |
| **Poland** | • HTGR for process heat application to be implemented in parallel to large LWRs  
• 10 MW(th) experimental HTGR at NCBJ proposed possibly with EU cooperation  
• Participating in regional TC project on SMRs |
Member states in Europe / Eurasia area that plan to initiate or to expand their nuclear energy programme have identified the need to increase their capacity to make knowledgeable decisions… particularly to become capable to identify and perform technical assessments for SMRs commercially available for near term deployment.

Overall objective to contribute to a new way to meet the European demand for clean and emission-free flexible sources of electricity.

Technically aspects supported by NE and NS Departments

A two-year project (2018/19)

3 Workshops in 2018: SMR technology (x2) and on Infrastructure, economic and financing aspects

In 2019 activities on Non-electric applications, IAEA technology assessment, Regulatory framework and licensing issues; Siting and Design Specific Issues

RER 2/014 Participants / beneficiaries

Albania
Armenia
Azerbaijan
Croatia
Czechia
Greece
Hungary
Lithuania
FYR Macedonia
Poland
Romania
Russia
Slovakia
Tajikistan
Turkey
Ukraine
A new Toolkit to help embarking countries in applying the IAEA methodology on Reactor Technology Assessment → *also for SMR*
SMR Simulator for Education

iPWR Simulator, available to download for free

- 150 MWth, integral type PWR, 14 systems including various integrated passive safety systems

**Passive systems**
- Automatic Depressurisation system (ADS)
- Pressure Injection system (PIS)
- Gravity Injection system (GIS)
- Passive heat removal system (PDHR)

Planned SMR Simulator, advanced and innovative reactors

- Based on SMART Design (Under consideration)
- Based on HTGR design (Technical specifications available; Possible donation from INET, China)
- Based on SFR design (Technical specifications available)
Thank you!

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